MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2018/2019

TIT3131 – INFORMATION THEORY

(All sections / Groups)

1 June 2019
9.00 am - 11.00 am
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 6 pages with **Five** questions only.
2. Attempt **All** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

QUESTION 1

(a) Classify the elements of digital communication system for '*X*' and '*Y*' in **Table 1** with their respective goals.

Elements	*Goals*
X	*Minimize the size of code words.*
Y	*Add redundancy to the source code word in order to correct errors introduce by the channel.*

Table 1

[2 marks]

(b) A source emits one of **25** possible symbols from a Scrabble game. **Figure 1** shows **20** available symbols and **5** similar vowels is pending at the next move.

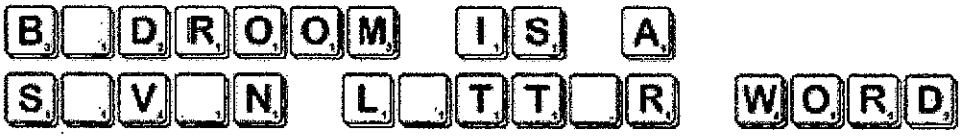

Figure 1

i. What is the expected vowels in the next move? Complete the following table and calculate the amount of information for all ***vowel*** symbols only. [6 marks]

k	1	2	3	4	5	6	7	8	9	10	11	12	13	14
S_k	S_1 = **'B'**	S_2 = **'D'**	S_3 = **'R'**	S_4 = **'O'**	S_5 = **'M'**	S_6 = **'I'**	S_7 = **'S'**	S_8 = **'A'**	S_9 = **'V'**	S_{10} = **'N'**	S_{11} = **'L'**	S_{12} = **'T'**	S_{13} = **'W'**	S_{14}
p_k														

ii. Show the information rate of this source if one of the **25** symbols is emitted, once every ***nanosecond***. [4 marks]

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QUESTION 2

(a) Explain whether code I and code II in **Table 2** are uniquely decodable using Kraft inequality. [2 marks]

Symbols	Code I	Code II
A	0	0
B	10	11
C	11	100
D	111	011

Table 2

(b) A discrete memoryless source uses the symbols A, B, C, D, E, and F with the following probabilities.

$$P(A) = x,$$
$$P(B) = 0.03,$$
$$P(C) = 0.13,$$
$$P(D) = 0.22,$$
$$P(E) = 5x,$$
$$P(F) = 0.32$$

i) Find the value of x and calculate the entropy of the source. [2 marks]

ii) Construct a Huffman for this code. [5 marks]

iii) Calculate the ***average length*** of the Huffman code and give the ***redundancy*** of the code. [2 marks]

iv) Decode the following bit string into a string of symbols with Huffman codes that gives a unique answer. [1 mark]

11011100001

Continued...

QUESTION 3

(a) A source X produces letters from a two symbol alphabet with the probability assignment $P_x(0) = 0.8$ and $P_x(1) = 0.2$. Each source letter x is transmitted through a channel as shown in **Figure 2** and the transition probabilities are indicated as below.

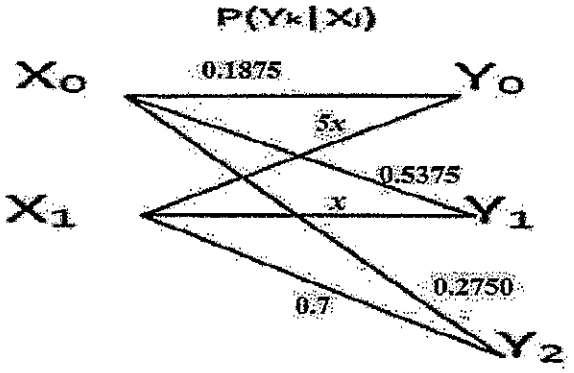

Figure 2

i. From **Figure 2**, what is the value of x? Prepare the conditional probability P(y|x) and joint probability tables P(y,x). [5 marks]

ii. Write all the steps to show that I(Y,X) equal to I(X,Y). [5 marks]

(b) Describe **TWO** characteristic of ***efficient*** source encoding. [2 marks]

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QUESTION 4

(a) Error-control codes are classified into block codes and convolutional codes. Differentiate between these two codes. [4 marks]

(b) A (7,4) linear block code has a coefficient matrix, P as below:

$$P = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$

i. Construct a generator matrix, G for the linear block code. [2 marks]

ii. Based on the generator matrix, G constructed above, construct a parity check matrix, H. [2 marks]

iii. Construct the table of error pattern and their corresponding syndrome for the linear block code. [2 marks]

iv. Assume a codeword $c = [0\ 1\ 0\ 1\ 0\ 0\ 1]$ is sent and the codeword $r = [0\ 1\ 0\ 1\ 0\ 1\ 1]$ is received. Show how the error can be detected and corrected. [2 marks]

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QUESTION 5

(a) A generator polynomial of a (7,4) cyclic code is given by

$$g(D) = 1 + D + D^3$$

Assume that a message 0011 is sent through the system. Find the valid code words in both non-systematic and systematic form. [4 marks]

(b) Given the convolutional code of path 1 and path 2 as follow.

$$g_1 = [0, 0, 1]$$
$$g_2 = [1, 1, 0]$$

i. Illustrate the convolutional encoder corresponding to the codes. [2 marks]

ii. What are the values of code rate and constraint length of the convolutional encoder? [2 marks]

iii. By using the code tree, trace the output of the encoder for the message sequence 1011. [4 marks]
(Note: The message is input from right to left)

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